

PHILOSOPHICAL TRANSACTIONS.

Monday, June 15. 1668.

The Contents.

An Account of a Controversy betwixt Stephano de Angelis, and John Baptista Riccioli, concerning the Motion of the Earth. An Enlargement of the Observations formerly publisht Numb. 27. imparted by a Curious Travellour to Jamaica; Where do occur Discourses about the Steams of the Sea; the Colour of the Sea; various Plants and Animals in Jamaica, and other Islands of the Caribes; the qualities of Tobacco growing in Nitrous Ground; Hurricans; a way to make a Boat ride at Anchor in the main Sea; the effects of the Change of Climat on Human Bodies; a probable way of Preventing and Curing Sicknes in Travellers to the West-Indies, &c. An Extract of a Printed Letter, address'd to the Publisher, touching a late difference, risen at Paris, about the Transfusion of Bloud. An Account of two Books: I. THE PROGRESS and ADVANCEMENT of KNOWLEDGE since the dayes of ARISTOTLE; by JOS. GLANVILL. II. ABRAH. COULEII Sex Libri PLANTARUM.

An Account

Of a Controversy betwixt Stephano de Angelis, Professor of the Mathematicks in Padua, and Joh. Baptista Riccioli Jesuite; as it was communicated out of their lately Printed Books, by that Learned Mathematician Mr. Jacob Gregory, a Fellow of the R. Society.

Riccioli in his *Almagestum Novum* pretends to have found out several new demonstrative Arguments against the Motion of the Earth. *Steph. de Angelis*, conceiving his Arguments to

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be none of the strongest, taketh occasion to let the world see, that they are not more esteem'd in *Italy*, than in other places. *Manfredi*, in behalf of *Riccioli*, endeavours to answer the Objections of *Angeli*, and this latter replies to *Manfredi's* Answer. The substance of their discourse is this following.

Although the Arguments of *Riccioli* be many, yet the strength of them consists chiefly in these three :

The first.

Multa corpora gravia, dimissa per Aerem, in Plano Aequatoris existentem, descenderent ad Terram cum Velocitatis Incremento reali & notabili, & non tantum apparenti. Sed si tellus moveretur motu diurno tantum circa sui centrum, nulla corpora gravia, dimissa per Aerem, in Plano Aequatoris existentem, descenderent ad Terram cum velocitatis incremento reali ac notabili, sed tantum cum apparenti. E. Tellus aut non movetur, aut non movetur diurno tantum motu.

The second.

Si Tellus moveretur motu diurno, aut etiam annuo, multò debilior esset ictus Globi bombardici explosi in Septentrionem aut Meridiem, quàm ab Occidente in Orientem. At consequens est falsum. E. & antecedens.

The third.

Si Tellus diurna revolutione moveretur, Globus argillaceus unciarum 8. ex altitudine Romanorum pedum 240. per aerem quietum dimissus, obliquo descensu in Terram delaberetur absque incremento reali ac physico velocitatis, vel certè nunquam tanto, quanta est proportio percussione ac soni per casum ex dicta altitudine facti. Sed posterius est absurdum. E. & prius.

In Answer to the first of these Arguments, *Angeli* denieth the Motion, which *Riccioli* pretends to prove thus;

Si Tellus moveretur solo diurno motu, aliquod Grave, dimissum ex Turris vertice C in Plano Equatoris existentis, describeret suo motu naturali portionem lineæ CTI, quæ esset ad omnem sensum circularis.

V. Fig. I.

This *Angeli* denies, shewing by Computation, that *Riccioli* his Observation proveth no such thing. For (saith *Angeli*) according to *Riccioli*, in one second of an hour the weight descends 15 foot; in 2 seconds, 60 foot; in 3 seconds 135 foot; and so continually the spaces from the beginning are in duplicate proportion of the Time from the beginning; and, according to the

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Fig. 1

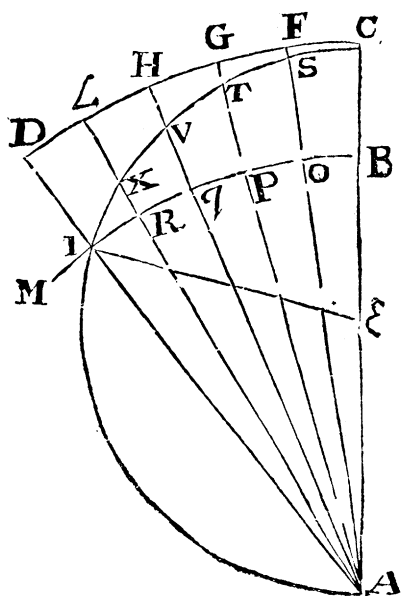
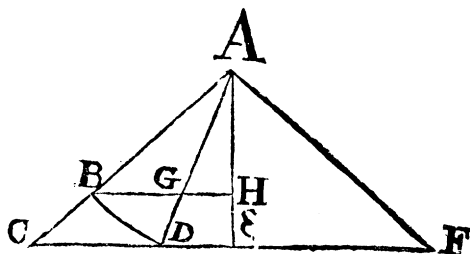


Fig. 2



same Author ; AB (the *semi-diameter* of the Earth) is of 25870000 foot, and BC (the height of the Tower of the *Afinelli* in *Bononia*) of 240 foot ; and therefore AC is 25870240, which hath the same proportion to FS, 15 foot, to wit, ye fall in one second, which AC in parts 20000000000 hath to FS 11596 $\frac{54356}{224189}$; but supposing, with *Riccioli*, CSIA a semi-circle, FS is 53 parts, of which AC is 10000000000 : Hence concludeth *Angeli*, that CSIA is no wayes near to a *semi-circle*, which is most sure, if so be the weight fall not to the Center of the Earth precisely in 6 hours : For, in this case of *Riccioli*, the weight falls to the Center of the Earth in 21 minutes and 53 seconds.

Manfredi in his Answer for *Riccioli* affirms, that *Angeli* understands not the *Rule of Three*, in giving out FS. for 11596 $\frac{54356}{224189}$, of which AC is 20000000000 : And *Angeli* in his Reply affirms his Analogy to be so clear, that there can be nothing said more evident than it self to confirm it ; referring in the mean time the further determination to Geometers.

Angeli might have answer'd *Riccioli's* Argument, granting the weight to move equally in a *semi-circle*, by distinguishing his *Minor* thus ;

Nulla Corpora gravia descenderent ad Terram cum velocitatis incremento reali ac notabili, si Velocitas computetur in circumferentia semi-circuli ; Minor propositio est vera. At non computatur ita Motus descensivus : nam hic motus aequalis in circumferentia semi-circuli CIA, componitur ex motu equali in quadrante CD, & motu accelerato in semidiametro mobili CA ; & hic motus acceleratus in semidiametro est verus & simplex motus descensivus ; in qua acceptione Minor propositio est falsissima, & Riccioli etiam experientiis contraria. But it seems, that *Angeli* answereth otherwise, to make *Riccioli* sensible, that CIA is no semicircle ; concerning the nature of which Line they debate very much throughout the whole discourse.

The second Argument is much insisted upon by *Angeli*, to make his solution clear to vulgar capacities ; but the substance of all is, That the *Canon-ball* hath not only that violent motion, impressed by the Fire, but also all these motions proper to the Earth, which were communicated to it by the impulse received from the Earth :
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for, the Ball, going from West to East, hath indeed two impulses, one from the Earth, and another from the Fire; but this impulse from the Earth is also common to the mark, and therefore the Ball hits the mark only with that simple impulse, received from the Fire, as it doth being shot towards the North or South; as, *Angeli* doeth excellently illustrate by familiar examples of Motion.

To *Riccioli* his *third* Argument *Angeli* answereth, desiring him to prove the sequel of his *Major*, which *Riccioli* doeth, supposing the *curve*, in which the heavy body descends, to be composed of many small right lines; and proving, that the motion is almost always *equal* in these lines; and after some debate, concerning the equality of motion in these right lines, *Angeli* answers, that the *equality* of *motion* is not sufficient to prove the *equality* of *percussion* and sound, but that there is necessary also *equal angles* of *incidence*; which in this case he proveth to be very *unequal*. To illustrate this more, let us prove, that, other things being alike, the proportion of two percussions is composed of the direct proportion of their *velocities*, and of the direct proportions of the *Sines* of their angles of incidence. *Supponamus autem sequens principium, nempe, quod percussiones (ceteris paribus,) sint in directa proportionem cum velocitatibus, quibus mobile appropinquat planum resistens.* Fig. 2da. Sit planum CF, sintque duo mobilia omni modo equalia, & similia, quæ motu equali accedant à puncto A. ad planum CF, in rectis AD, AF: dico, percussione in puncto D ad percussione in puncto F. esse in ratione composita ex ratione velocitatis in recta AD. ad velocitatem in AF, & ex ratione sinus anguli ADE ad sinum anguli AFE. Ex puncto A in planum CF, sit recta AE normalis, sitque recta AC equalis rectæ AF, & AB equalis rectæ AD, & planum BGH, parallelum plano CF: supponamus mobile, prioribus simile & aequale, moveri equaliter in recta AC, eadem velocitate, qua movetur mobile in recta AD: quoniam plana BGH, CF, sunt parallela, & motus in recta AC est æqualis, igitur mobile eadem velocitate accedit ad planum BH, qua ad planum CF, & proinde percussiones in punctis B, C, sunt æquales; atque percussio in puncto D, est ad percussione in puncto B, ut recta AE ad rectam AH, seu (ob æquales rectas AD, AB) ut sinus anguli ADE ad sinum anguli ABH, quod sic probō; velocitas mobilis in recta AD, est æqualis velo-

velocitati mobilis in recta AB, ipsi AD aequali, & ideo eodem tempore perficitur utraque recta AD, AB; & proinde eodem tempore perficiuntur accessiones ad plana resistentia AE, AH; ideoque velocitates accessionum ad plana resistentia sunt in directa ratione AE ad AH, atque ideo percussio in puncto D. est ad percussionem in puncto C. in eadem ratione AE ad AH; nempe ut Sinus anguli incidentiae ADE. ad sinum anguli incidentiae ACE, vel AFE. Quoniam autem recta AC, AF, equaliter inclinant ad planum CF, mobilia in rectis AC, AF, accedunt ad planum CF, in eadem proportione qua moventur in rectis AC, AF; & ideo percussio in C est ad percussionem in F in ratione velocitatis motus in AC seu in AD ad velocitatem motus in AF; At demonstratum est antè, percussionem in puncto D ad percussionem in puncto C, esse in ratione sinus anguli ADE ad sinum anguli AFE, & nunc demonstratum est, percussionem in puncto C esse ad percussionem in puncto F, ut velocitas motus in AD ad velocitatem motus in AF. Igitur ex 5. defin. 6. Elementorum, percussio in D, est ad percussionem in F, in ratione composita ex ratione sinus anguli incidentiae ADE, ad sinum anguli incidentiae AFE, & ex ratione velocitatis in AD ad velocitatem in AF; quod demonstrare oportuit. Neminem moveat, quod hac demonstratio adstricta sit motibus aequalibus in lineis rectis & planis resistentibus; est enim vera in omni casu: nam, cum percussiones fiant in puncto, in hoc coincidunt rectum, curvum, aequale, & inaequale; si autem in punctis percussiones non fiant, de illis non potest dari consideratio geometrica, sed judicandus est conclusionis defectus secundum defectum materiae à conditionibus requisitis, sicut semper fieri debet, dum demonstrationes geometrica corpori physico applicantur.

In *Angeli* his reply to *Manfredi*, he maketh mention of an Experiment, which (as was related to him by a *Swedish Gentleman*) had been made with all due circumspection by *Cartesius* to prove the Motion of the Earth. The experiment was; He caused to be erected a Canon perpendicular to the Horizon; which being 24 times discharged in that posture, the Ball did fall 22 times towards the West, and only twice toward the East.